SOIL SURVEY OF THE VENTURA AREA, CALIFORNIA.

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LOCATION AND BOUNDARIES OF THE AREA.

Ventura County is situated on the coast and is bounded on the east and southeast by Los Angeles County, on the southwest by the Pacific Ocean, on the west by Santa Barbara County, and on the north by San Luis Obispo and Kern counties. It was at one time a part of Santa Barbara County. (See fig. 20, p. 477.)

Altogether the county contains 1,852 square miles (1,185,705 acres), but only a small part of this is agricultural land. The area mapped, comprising about 240 square miles (153,485 acres) and including practically all of the arable land of the county, extends from the Ojai Valley down Ventura River to Ventura City. From there it spreads out, taking in the broad delta of the Santa Clara River, which is the great cultivated area of the county. Pleasant Valley and the narrow portion of the Santa Clara Valley to a point about 4 miles east of Fillmore are also included. All these valleys are bounded on the land side by hills or mountains of sandstone and shale in various stages of consolidation. The Santa Clara Valley is bounded on the southwest by the Pacific Ocean. The four principal towns in the area are Ventura, Oxnard, Santa Paula, and Hueneme. The base map used for the survey is from the official survey of the county.

PHYSIOGRAPHY AND GEOLOGY.

The greater part of the 1,852 square miles of territory in Ventura County is rough, broken mountains, valuable only for the mineral products, the timber, and the scant pasturage they afford. In the remote northern and eastern portions of the county the mountains are of granite and volcanic rock, but the hills and mountains immediately surrounding all the cultivable lands are of sandstone or shale. Santa Clara River enters the county from the east and flows in a westerly direction to the ocean. Piru, Sespe, and Santa Paula creeks enter from the north. These tributaries, coming as they do from areas of different geological formations, make the sediment of Santa Clara River of complex character and produce the Oxnard types of soil.

The Ventura River rises in the northern part of the county, in the Santa Ynes Mountains, and flows south to the ocean. Its tributaries

are Arroyo San Antonia, Canada Leon, Santa Ana Creek, Canada Larga, and Los Coyotes Creek. No considerable delta is formed at its mouth.

For the greater part of the year both the Santa Clara and Ventura rivers are dry in their lower reaches. But in the rainy season, which comes in the winter months, both are raging torrents. The Santa Clara, however, is much the larger of the two.

The delta of the Santa Clara is the principal agricultural area of the county. It is a low, gently sloping plain which has been slowly formed by the sediment of the river and its tributaries. Sand dunes 20 to 60 feet high form a fringe along the ocean side. Along the entire northern side is a low range of unconsolidated argillaceous sandstone, in some places capped by conglomerate. Along the south side of the Santa Clara River and the narrow part of the valley, to about 1½ miles east of Saticoy, are the Santa Paula Mountains. Their north side is composed of very rugged, precipitous walls of white sandstone and shale. A little east of Saticoy the valley widens, extending east and south to the ocean.

A change of level separates the lands immediately south of the Santa Paula Mountains from the Santa Clara Valley proper. This mesa land extends as far south as Springville, where it terminates in a range of hills similar to those on the northern side of the valley and extending in a northeasterly direction to the town of Somis. No striking change of level takes place between Springville and Somis, so that the Santa Clara Valley from Ventura to Somis, and south to the point of mountains at Estero Grande, is one broad, level plain. The southern slope of the Santa Paula Mountains, which forms the northern boundary of the valley included in the Las Posas grant, rises gradually from low, undulating hills to higher ones, till the summit of the mountains is reached. North and east of Somis a change in geological formation gives rise to entirely different physiographic features and new types of soil. Here there are no level portions of land of any great extent, the whole county being composed of rolling hills.

From Ventura the Ventura River flows nearly straight northward to Ojai Valley. For the first 10 miles northward the river runs between hills of soft shaly sandstone similar to those on the northern side of Santa Clara Valley. For this distance the river is flanked by a very narrow strip of cultivable soil. This narrow strip of land broadens out into the Ojai Valley, which is a rolling, broken valley bounded on the north by very high and precipitous sandstone mountains and on the south, east, and west by lower and less precipitous mountains of the same formation. Only a part of the valley is level enough to allow irrigation.

CLIMATE.

The climate of the cultivated portions of Ventura County is mild and equable. Farther back from the coast, in the mountainous district,

the climate is more variable, quite a difference existing between the winter and summer temperature. The appended table, compiled from the Weather Bureau records, shows the normal monthly and annual temperature and precipitation for the two points in Ventura County that have had a Weather Bureau service long enough to establish these normals, and for Newhall, which is situated in Los Angeles County, near the boundary line. Newhall is on the Santa Clara River east of Santa Paula, and is given merely to show how the differences in summer and winter temperature and precipitation increase as the distance from the coast and the elevation become greater. Ventura is situated directly on the coast; hence only a slight range in temperature is found there, 12.2°. Santa Paula is 16 miles from the coast, just inside the upper narrow portion of the Santa Clara Valley. Here the range is 16.1°, while at Newhall, several miles eastward, it is 29.5°.

Normal monthly and annual temperature and precipitation for Ventura County, Cal.

Month.	Temperature.			Precipitation.		
	Newhall.	Santa Paula.	Ventura.	Newhall.	Santa Paula.	Ventura.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
January	48.0	52.1	52.5	2.60	3.17	3.12
February	50.0	53.4	53.5	3.43	2.48	2.09
March	54.9	56.2	52.7	2.80	3.30	2.64
April	58.7	60.5	56.0	1.50	.37	.40
May	64.3	63.7	58.0	.45	.38	.29
June	70.6	65.0	61.0	.13	.00	Tr.
July	76.6	68.1	63.0	Tr.	.01	.05
August	77.5	68.2	64.7	.03	.01	Tr.
September	71.3	66.1	61.1	.07	.32	.36
October	62.1	62.2	59.7	.70	.....	.60
November	54.7	59.0	56.1	1.42	.45	.67
December	49.3	54.7	54.2	3.68	4.04	2.20
Annual	61.5	60.7	57.8	15.81	*14.53	12.42

*Total for eleven months.

The valley of the Santa Clara is so shaped, with its long, narrow neck extending eastward and making a pass through the hills to the heated portion inland, that all summer long, beginning about 8 o'clock a. m., cool ocean breezes sweep the valley as they rush inland to this heated desert land. At night the valley is shrouded in dense fog. It is generally believed that these moist day winds and nightly fogs account, in a great measure, for the fact that summer crops can be grown here with no rainfall from the time of planting until harvest, although the winter rainfall is often less than 15 inches. These daily ocean winds continue until about the middle of October, when at intervals the order is reversed and every few days a period of east winds prevails. At times these east winds blow with great fury, catching up the dust and sand and drifting it along fences and wind-breaks. These sand drifts are sometimes many feet in height.

The rainfall is principally in the winter months. Very little precipitation occurs between the 1st of May and the 1st of November. Fifteen inches is about the annual average, although for the past four or five years much less than this amount has fallen. For the kinds of crops grown, if properly cultivated, 15 inches is enough.

The cool day breezes and cool nights make this climate a very pleasant one. The prevailing fogs, however, have made it a less inviting place for those suffering from throat or lung troubles than many other parts of southern California.

SOILS.

In making a detailed study of the soils of Ventura County, thirteen distinct types were recognized as follows:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
River wash	13,610	8.8	Placentia sandy loam	23,878	15.6
Fresno sand (gravelly phase)	6,432	4.2	Salinas shale loam	2,544	1.6
Fresno fine sandy loam	12,896	8.4	Fullerton sandy adobe	1,946	1.3
Oxnard silt loam	5,325	3.5	San Gabriel gravelly loam	4,307	2.8
Oxnard sand	16,198	10.6	Dunesand	2,023	1.3
Oxnard sandy loam	53,203	34.7	Total	153,470	.....
Oxnard loam	6,829	4.4			
San Joaquin black adobe	4,294	2.8			

The Oxnard types are found principally near the coast and are formed either from the mixed sediments of the rivers and their tributaries, as found on the delta of the Santa Clara, or are derived from the direct washings of the unconsolidated shaly sandstone of the coast range of hills. The Fullerton sandy adobe, San Gabriel gravelly loam, and Placentia sandy loam are formed either by the washings or by the breaking down in place of the sandstone of different geological formations and are found farther back from the coast. The Oxnard types form the principal agricultural lands of the county. The large delta of the Santa Clara River is entirely composed of them.

RIVER WASH.

This soil is found in long, comparatively level strips, as the beds of streams. It is formed of bowlders, sand, and gravel washed into the streams by floods from the heavy downpours of rain in the mountains. In the upper parts of streams this soil is often composed almost entirely of bowlders and large pebbles, but in the lower levels it is principally coarse sand. This type of soil is of no agricultural value.

FRESNO SAND (GRAVELLY PHASE).

Except for a large area south of the Santa Clara River, this soil is found only in small patches or as long, narrow, gently sloping valleys

that in the rainy season are beds of streams. The small patches are found along the base of hills at the point of issuance of small canyons. This soil is the coarsest wash from the hills surrounding the valleys, the finer particles being carried farther out on the delta. The soil and subsoil is a loose, incoherent grayish sand containing a high percentage of gravel.

This gravelly phase of the Fresno sand of Ventura County is nearly always planted to lima beans, one of the principal crops of the county. It is well adapted to the growing of this crop and as much as 2,000 pounds of dry beans have been produced on a single acre, although this yield is exceptional. The soil is always well drained and free from alkali salts.

No mechanical analysis of this soil was made, on account of the great difficulty of obtaining an average sample of the soil.

FRESNO FINE SANDY LOAM.

The Fresno fine sandy loam is found principally north of the Santa Clara River, although small areas are found throughout the district mapped. It occupies gently sloping plains lying near the foothills, or skirting the deep gullies, or barrancas, which have in some places been cut into the soil by the waters that drain from the hills surrounding the plain. It is derived from fine-grained unconsolidated sandstone, or is deposited along overflow parts of streams, the finer material in either case being carried farther below, leaving this soil a fine sand having the properties of a sandy loam. It is wonderfully uniform in texture and sometimes many feet in depth. It is generally, however, comparatively shallow—3 to 6 feet deep—having for a subsoil the soil of the area overflowed.

The Fresno fine sandy loam is quite generally planted to lima beans, of which it yields large crops. A yield of 2,000 pounds of dry beans is often produced on an acre without irrigation, or 2,500 pounds with irrigation. Considerable areas of this soil north of the Santa Clara River, in the vicinity of Santa Paula, are planted to English walnuts. It is perhaps the best soil in the county for these trees. Small areas are also devoted to the citrus fruits. With irrigation or a large rainfall these trees bear well and are very profitable. The soil may be said to be particularly adapted to lima beans and English walnuts. Owing to its position along the hill slopes or deep gullies it is always well drained and free from alkali salts.

The following table gives the texture of a typical sample of this soil:

Mechanical analysis of Fresno fine sandy loam.

[Fine earth.]

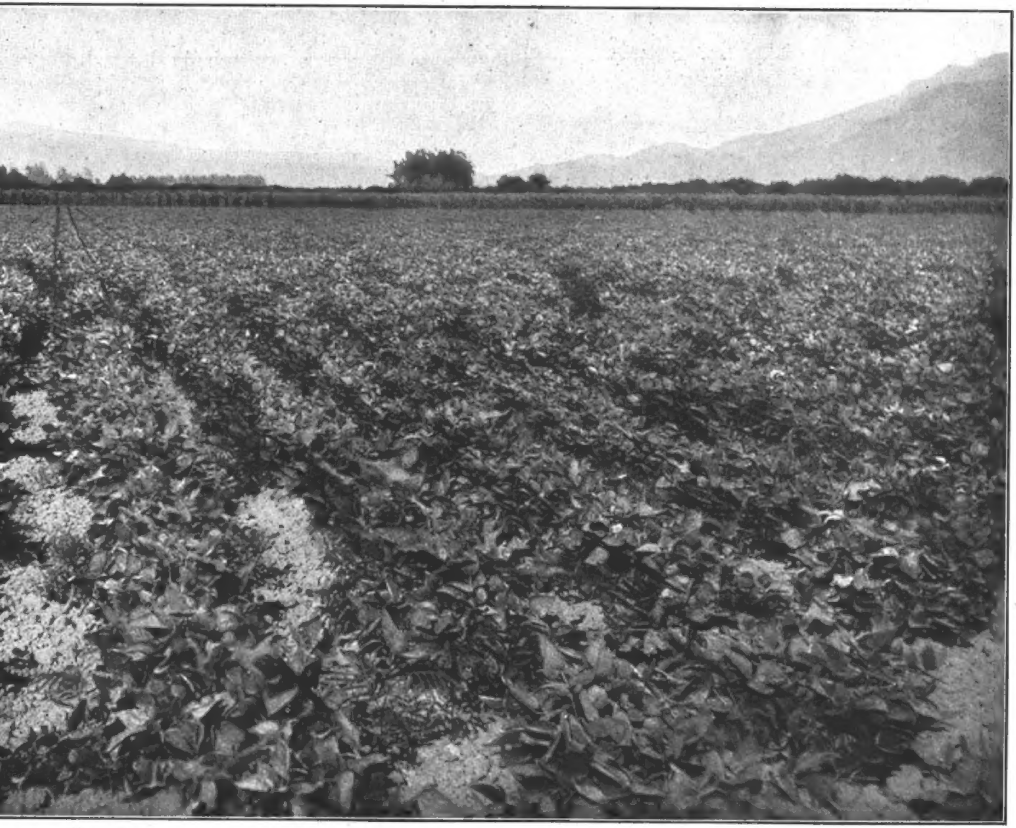
No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
6165	¼ mile W. of Fillmore.	Sandy loam, 0 to 30 inches.	0.12	4.32	0.78	3.38	3.88	23.06	7.44	42.30	15.36

OXNARD SILT LOAM.

The Oxnard silt loam, like the fine sandy loam, is found almost entirely north of the Santa Clara River. One large area is found elsewhere—on the Calleguas Rancho, east of the junction of Arroyo Simi and Arroyo Santa Rosa. This soil occurs in almost level plains. In some places, however, notably east of Ventura, it is slightly undulating, giving evidence of having been eroded or crumpled since its deposition.

The Oxnard silt loam has been formed by the deposition of the finer particles held in suspension by the flood waters of the Santa Clara River or of the smaller streams. On the north side of the river, except below the mouths of the long, deep barrancas that still bring down sediment from the hills, the formation of this soil has stopped. But some of these streams, confined to their beds by perpendicular banks 20 to 60 feet high for a while after emerging from the foothills, lower down flow out on the level plain, forming small fan-shaped areas of the gravelly phase of the Fresno sand, below this larger areas of Fresno fine sandy loam, and still below this areas of Oxnard silt loam. On the Dixie Thompson Ranch near Ventura dikes have been thrown up, diverting the flood waters of Arundell Barranca upon lands originally shifting sands. In this way several acres of valuable land are annually added to the ranch by covering these unproductive sands with a layer of silt loam. The silt loam on the Calleguas Ranch receives a fresh coating every year by the floods from Arroyo Santa Rosa.

The Oxnard silt loam is composed of the finer particles of disintegrated sandstone mixed with fine particles of organic matter, and its physical properties are somewhat like those of the well-known loess soil. It is a brown, friable, easily cultivated, very fertile, and pro-



FIELD OF LIMA BEANS—THE PRINCIPAL CROP OF THE VALLEY.

ductive soil. In most instances north of the Santa Clara River it is very deep. According to records obtained from artesian-well borers this soil, with only slight modification, has been found to extend to a depth of 300 feet.

The greater part of the Oxnard silt loam is annually planted to lima beans, of which it yields a fair crop. The yield is not so large as on the sandy soils, however, 1,000 to 1,800 pounds of dry beans per acre being the range for unirrigated fields, although where the land is irrigated 2,500 pounds are sometimes produced.

Apricots were at one time extensively planted on this soil, but the last few dry years have greatly injured them, showing that their growth, without irrigation, is unsafe. A few walnut trees are planted, which with irrigation do well, but which without it are liable to be injured by drought. Citrus trees are grown in the vicinity of Santa Paula, and while the fruit is not of the first quality or the yields large, the returns are satisfactory. Corn may be grown upon the silt loam, and at one time was grown quite extensively, yielding large crops without irrigation. Other crops are so much more valuable, however, that corn has been almost abandoned. Barley yields immense crops, but since it can be grown in almost any part of the State it is now used in Ventura County chiefly as a rotation crop.

The soil can be said to be adapted to the growing of lima beans, corn, and barley without irrigation and lima beans, walnuts, and deciduous and citrus fruits with irrigation. The silt loam is nearly always well drained and free from alkali salts.

Mechanical analyses of typical samples of this soil are given in the following table:

Mechanical analyses of Oxnard silt loam.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4809	Patterson ranch..	Silty loam, 0 to 24 inches.	2.05	6.42	.....	0.26	0.80	3.16	7.16	68.66	11.67
4817	Patterson ranch..	Silty loam, 0 to 24 inches.	.59	8.54	.....	.48	.52	20.34	11.62	40.52	17.67
4810	Subsoil of 4809....	Silty loam, 24 to 72 inches.	1.55	3.97	1.12	.68	1.44	11.68	8.92	58.43	10.47
4818	Subsoil of 4817....	Silty loam, 24 to 72 inches.	1.22	3.19	.78	.60	1.30	27.06	16.16	31.80	15.78

OXNARD SAND.

The greater part of the Oxnard sand is situated on the delta south of Santa Clara River. Other smaller areas are found along the courses of minor streams and near old stream beds throughout the district mapped. It originally occurred in gently sloping plains with comparatively level surfaces. As soon as cultivation began and the fields were bare in the fall of the year, at which time the strong east winds blow, these sands began shifting about. In some places dunes were formed several feet in height. This shifting greatly interfered with cultivation. Not only did the winds blow away the most fertile part of the soil, but often the crops were destroyed. As a last resort the farmers began planting trees, which developed into the system of wind-breaks described in another chapter.

The sands of the Santa Clara Valley were deposited by the river as it shifted about over the delta. In very recent years the Santa Clara River flowed almost straight south from the western end of Santa Paula Mountains to Estero Grande. Along this old bed of the river are large areas of sand. The shifting of the smaller streams has formed the smaller areas found along their courses.

The Oxnard sand is a brownish, principally quartz sand, ranging in texture from medium to fine sand. It is usually 10 or 12 feet deep, underlain by a heavier soil grading into clay. In some places it has some of the properties of the Oxnard sandy loam into which it almost imperceptibly grades. The grains of sand have been somewhat rounded by the constant action of the wind and have a smooth feel, like beach sand. In some places, where salt-impregnated standing water is close to the surface, gypsum has been crystallized out in the sand, slightly cementing it. Frequently the percentage of gypsum is sufficient to give the soil a sandy-loam texture.

Oxnard sand when free from alkali is planted almost exclusively year after year to lima beans. There are places where beans have been grown on the same field for twenty consecutive years with no diminution in the yield. The beans yield on this soil when unirrigated 1,200 to 2,000 pounds, and when irrigated 2,000 to 3,000 pounds per acre. Walnuts are also grown on the Oxnard sand, and with irrigation they produce very well. The other crops of the valley, such as beets, barley, corn, etc., may be grown on this type, but the crops which are best adapted to it are lima beans and English walnuts.

Along the old bed of the Santa Clara River from the western end of Santa Paula Mountains to Estero Grande there are places where the Oxnard sand contains enough alkali to damage beans, walnuts, and the other more sensitive crops, but not enough to interfere with the production of beets and barley. Where the alkali does not exceed 1 per cent these resistant crops are grown at a good profit. Generally

in the alkaline portions there is but a thin coating of sand underlain by a heavier soil. Such a soil is an excellent one for beets, the sand permitting the beets to shape themselves properly, while the subsoil furnishes a rich feeding ground for the smaller roots. In 1901 the beets from 7 acres of this kind of soil near Hueneme brought, delivered at the sugar factory, $1,134, or at the rate of $162 an acre. The yield was at the rate of about 30 tons per acre.

The following analyses show the texture of this soil type:

Mechanical analyses of Oxnard sand.

No.	Locality.	Description.	Soluble salts as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4816	Patterson ranch..	Sand, 0 to 24 inches.	0.25	2.04	2.52	10.16	37.10	31.08	10.00	4.64	1.85
4799	Patterson ranch..	Sand, 0 to 36 inches.	.98	4.44	.....	1.96	20.78	29.10	22.18	15.00	5.18

OXNARD SANDY LOAM.

This soil is the principal type of the county, and is found generally distributed throughout the area mapped, although the largest areas occur associated with the Oxnard sand on the delta of the Santa Clara River. Here it occurs as gently sloping plains of uniform grade. The hills of unconsolidated sandstone along the coast, as they break down, give rise directly to this soil. It is found capping them along the entire coast. Thus a fringe of this soil encircles the other soils on the north side of the Santa Clara River. On the hills it often occupies the steepest slopes.

As found on the delta of the Santa Clara River this soil is a mixture of the sediments from sandstone and shale hills, containing also a considerable percentage of organic matter. It has been formed by the Santa Clara River and the smaller streams that deposit their sediments upon the delta.

This delta soil is usually 4 or 5 feet deep and is underlain by sand or a heavier phase of sandy loam. It is a brown or black, friable, open soil, freely admitting air and water. It has a peculiar and characteristic woody feel, and is quite light in weight, from the presence of decomposed siliceous shale which has been brought down from areas having this formation and thoroughly mixed with the sandier

wash from the sandstone hills. The difference in color is due chiefly to the varying amounts of organic matter in the soil. It has a very high capillary power, being able to lift water from great depths; hence crops planted upon it are able to withstand droughts in a marked degree.

The foothill areas of the Oxnard sandy loam are a little more sticky and plastic than the valley soils, and are also of uniform light-brown color. The small outlying areas formed by the mixture of wash from near-by hills do not differ materially in mechanical composition from the larger areas of the same type.

When free from alkali the level valley lands of this type are the very best for the growing of lima beans. Almost every foot of such land was planted to this crop year after year, with only an occasional crop of barley planted for rotation, until the advent of the sugar factory at Oxnard. As much as 3,000 pounds of lima beans have frequently been grown on an acre of this soil with irrigation, while a 2,000-pound yield is not at all uncommon without irrigation. Only very small tracts of the soil are planted to fruit trees. When it is free from alkali it is preeminently adapted to the growth of lima beans as well as to sugar beets.

Parts of the Oxnard sandy loam, beginning in the northern part of the Rancho Santa Clara del Norte and extending almost straight south to Estero Grande and thence around just inside the sand dunes to the northern side of the Patterson Ranch, are alkaline to a greater or less degree. The soil in these localities is somewhat heavier in its texture than that which is free from alkali, owing to the presence of gypsum in excessive amounts. This alkaline land is poorly drained, water being in most places not more than 10 feet below the surface and at certain seasons of the year much nearer. A few years ago only indifferent crops of barley were grown on the greater part of this soil, which was considered practically worthless, as quite often the barley hay contained such a great amount of salt that stock would not eat it. Now a great deal of the alkaline portion of this soil is planted to sugar beets with surprising results. Twenty tons of beets per acre, worth $100 or more, is no uncommon yield for land that only a few years ago was of no value, except for the scant pasturage it afforded.

The beets grown on the alkali land are usually large, and they contain a higher percentage of sugar than those grown on land that is free from alkali. However, a great deal of this land is too alkaline even to raise beets, and it will have to be reclaimed before it can produce any useful crop. The table following shows the texture of samples of the Oxnard sandy loam.

Mechanical analyses of Oxnard sandy loam.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4813	Patterson ranch ..	Black sandy loam, 0 to 30 inches.	2.00	7.56	.....	.....	0.68	14.80	42.32	29.36	4.24
4804	Patterson ranch ..	Black sandy loam, 0 to 36 inches.	4.04	5.32	.....	0.18	4.12	22.79	35.66	23.50	5.18
4801	Patterson ranch ..	Brown sandy loam, 0 to 24 inches.	1.06	5.24	.....	.....	2.28	19.48	37.96	26.26	7.62
4814	Patterson ranch ..	Brown sandy loam, 0 to 24 inches.	1.50	5.82	.....	.36	1.28	25.12	19.64	40.34	6.38
4808	Patterson ranch ..	Brown sandy loam, 0 to 36 inches.	.20	3.84	.48	2.30	6.64	30.20	18.00	27.56	10.50
6179	Santa Clara del Norte ranch.	Sandy loam, 0 to 36 inches.	.06	3.34	1.74	13.62	11.30	24.54	13.34	18.36	12.90
6180	Subsoil of 6179....	Heavy subsoil, 36 to 72 inches.	2.10	4.12	.48	2.34	2.68	16.50	14.22	27.84	30.92

OXNARD LOAM.

This soil is found in very small patches quite widely distributed throughout the district mapped. It is locally known as an adobe, but it is not so heavy, nor so sticky, as the real adobe, nor does it crack open when dry as does the true adobe soil. The largest area includes Springville and extends southward toward the ocean. Another quite large area is found north of Springville just after ascending the mesa at the western end of Pleasant Valley. Smaller areas are found east of this on Las Posas ranch and north of Santa Clara River. In the aggregate there is less than 2 square miles of this soil. It occurs mainly as gently sloping plains, although the area on the upper portion of Las Posas ranch is characterized by undulating hills. It is derived either from the degradation in place of a very argillaceous sandstone or from a deposit in comparatively still water. When formed in place it contains some coarse sand, while as a deposit it is of more uniformly fine particles. It is a heavy, sticky loam, usually underlain by a more compact and heavier phase of the same material.

Where it is free from alkali the level portions are usually planted to beans, in rotation with barley. It is an excellent barley soil, producing large yields with a normal rainfall. It is not well adapted to

the growing of beans, being difficult to cultivate and not producing as well as the lighter soils. Beans planted in it do not cover the ground as they do in the lighter soils, but grow up in a sort of bush, greatly lessening the bearing space of the vines. Twelve hundred to 1,500 pounds is considered a good yield.

Very few fruit trees are planted upon the Oxnard loam, as it is a poor fruit soil. The large area south of Springville is in the main alkaline, containing an average of 0.5 per cent of salts. While this is enough to exclude beans, barley and beets are grown quite extensively and profitably. A great deal of gypsum is contained in this soil, which gives the plowed fields their white appearance. Where well watered the Oxnard loam is particularly well adapted to the growing of barley and sugar beets.

Mechanical analyses of typical samples of this soil are tabulated below:

Mechanical analyses of Oxnard loam.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4815	Patterson ranch ..	Black loam, 0 to 24 inches.	0.76	6.74	.....	0.66	1.60	26.80	16.22	38.22	9.74
4806	Patterson ranch ..	Black loam, 0 to 36 inches.	1.48	4.90	0.52	.78	.56	13.70	10.80	51.98	13.64
6177	Crossing of Laguna and Woods roads.	Heavy loam, 0 to 48 inches.	1.98	4.20	Tr.	.98	1.68	12.34	15.32	30.78	32.28
6175	East side Santa Clara del Norte ranch.	Heavy loam, 0 to 46 inches.	.05	6.72	.....	.10	.16	1.44	6.92	45.58	38.97
6178	Subsoil of 6177....	Heavy subsoil, 48 to 72 inches.	2.60	3.08	.....	.50	1.56	22.20	16.68	28.46	24.64
6176	Subsoil of 6175....	Heavy subsoil, 46 to 72 inches.	.07	3.10	Tr.	.10	.04	1.16	8.26	47.96	37.63

SAN JOAQUIN BLACK ADOBE.

The San Joaquin black adobe is found principally just east of the delta of the Santa Clara River, in the hills and on the extensive mesa lands of Las Posas grant. It is usually found in low, rolling hills. The soil is derived from shale, and is either the result of the degradation of the rock in place or is the washings from the shale hills.

The San Joaquin black adobe is a black, sticky, plastic, claylike adobe 6 feet deep, underlain by heavy clay adobe or decomposing

shale. It possesses the property of cracking open when dry, large cracks sometimes 2 inches across being found in it in dry seasons. When once puddled it is almost impervious to water, but these wide, deep cracks, supplemented by a great number of smaller ones running through the soil at right angles, making it break down in small cubes, furnish openings through which the water may enter. This soil in Ventura is very similar to the adobe found in Los Angeles and Orange counties and other parts of California.

Barley is the principal crop grown upon this soil. Only small patches of beans are grown, and these yield but small crops, owing to the difficulty of cultivation and the fact that the beans on this soil, like those on the Oxnard loam, fail to send out vines, but grow up in bush form. Beets have been grown quite successfully on the lower, level portions of the soil, although the same difficulties of cultivation are there also a serious drawback. If beets are to be planted, the soil should be plowed very deeply (15 inches) in the fall, allowed to lie fallow all winter, and be given another shallow plowing in the spring. This deep plowing will scarcely be found profitable or possible unless steam plows are used. Similar soils in the Salinas Valley, in Monterey County, are plowed with steam plows and planted to beets with perfect success.

The western part of the large area north of Springville, and almost all of the area south of that town, is alkaline—some of it so much so that it will have to be reclaimed before useful crops can be grown.

The result of mechanical analysis of a sample of this soil is given in the following table:

Mechanical analysis of San Joaquin black adobe.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
6172	1¼ miles W. of Nordhoff.	Black adobe, 0 to 60 inches.	0.02	3.32	1.04	4.08	4.58	12.90	11.24	34.42	28.22

PLACENTIA SANDY LOAM.

The Placentia sandy loam is found principally in the eastern part of Las Posas grant, and as a special phase in the Ojai Valley and near Fillmore. It occurs on low rolling hills with narrow valleys between. It is derived from the disintegration of sandstone in place, the small valleys being filled with the soil creep from these hills.

It is typically a reddish-brown sandy loam 2 to 4 feet deep, underlain by a heavier phase of the same soil, which in some places approaches a sandy adobe. The southern part of the large area in the eastern part of Las Posas grant is a typical Placentia sandy loam, except for the subsoil. Here the subsoil is so hard and stiff that it is locally known as hardpan. In wet seasons water will stand for days in small depressions in that area without sinking into the soil. Farther to the north, as the hills become more precipitous, this heavy subsoil gradually disappears.

On the part of this soil having the heavy hardpanlike subsoil no deep-rooted crop can be profitably grown. Barley is the principal crop grown at the present time, and doubtless must continue to be.

Where this subsoil, however, is absent, the hills, in some places even the steepest of them, are cultivated to corn, black-eyed beans, and apricot orchards. Most of the hill lands that are thus cultivated were originally Government lands that have been taken up under the homestead laws in the usual 160-acre tracts. From several of these farms as much as 1,000 sacks of beans of 85 pounds each are annually sold, besides which enough hay and grain are raised for home consumption. The few who have planted apricot trees on these hills, and have properly cultivated them, have received fully as good returns as are obtained from the valley lands where irrigation is not used. This part of the county is certainly as susceptible of development as any other, and has been neglected only because the greater part of it is yet held in large tracts by nonresident capitalists who are content with the present nominal returns.

In the Ojai Valley and in the vicinity of Fillmore are found quite extensive areas of a sandy loam soil, which, though not a typical Placentia sandy loam, because of its close similarity was mapped as such. It is of a darker reddish color and in some places much deeper than the typical soil. In the Ojai Valley it is principally given to the growing of grain, hay, and the deciduous fruits without irrigation. It is well adapted to such crops. This soil at Fillmore is nearly all planted to citrus fruits, which do only fairly well. The Placentia sandy loam is all well drained and free from alkali salts.

A stony loam occurs in the Ojai Valley and along the base of the mountains on the north side of the river between Santa Paula and Fillmore. It generally occupies steep grades or broken irregular hills, although some areas are level enough to admit of irrigation. It is the result of the breaking down of the high sandstone mountains and the washing of bowlders and finer particles to these levels by floods. The entire surface of the soil is covered with subangular bowlders, some of which weigh hundreds of pounds. The interstitial material is Placentia sandy loam, and this soil has been shown on the soil map as Placentia sandy loam with gravel. The surface

YOUNG ORANGE GROVE NEAR SANTA PAULA.

bowlders have to be removed before any cultivation can take place. The fields are surrounded by high, wide walls built of stones removed from them. Oranges are the only crop grown on this soil in the Ojai Valley, the water for irrigation being obtained from small canyons in the large mountains at the north, and from tunnels driven into the sides of these mountains. At each successive cultivation the rocks that have been brought to the surface have to be removed, making the cultivation and management quite expensive. Only a scant water supply has as yet been obtained; but with much less water than is used elsewhere, and with no artificial fertilization, oranges of a superior quality are produced. The orchards of this district are entirely free from scale, and as yet the oranges have never been affected with the "puff." If plenty of water were obtainable, except for the expense of removing the stones, this soil would be well adapted to the growing of citrus fruits. It is always well drained and free from alkali salts.

The following table shows the texture of Placentia sandy loam:

Mechanical analyses of Placentia sandy loam.

[Fine earth.]

No.	Locality.	Description.	Soluble salts, as determined by mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
6170	1¼ miles NE. of Somis.	Sandy loam, 0 to 24 inches.	0.01	2.66	4.76	5.34	4.12	24.98	6.38	40.52	11.41
6169	4 miles SW. of Nordhoff.	Sandy loam, 0 to 66 inches.	.01	3.22	.90	3.66	5.78	24.38	4.00	38.76	18.29
6168	SE. cornersec. 11 of Ojai Valley.	Sandy loam, 0 to 18 inches.	.02	3.60	1.50	3.94	3.96	12.48	11.64	44.50	18.54

SALINAS SHALE LOAM.

The Salinas shale loam was found only in a limited district in Las Posas grant at the mouth of deep gullies which have their origin in the high mountains of the Santa Paula Range. It occurs in comparatively flat, gently sloping plains. The soil is derived from a very light, chalklike siliceous shale, being carried down by the flood waters and deposited on the plains below. This shale varies in color from white to deep red. It is very light in weight. The soil is simply this shale ground fine. The surface soil is this very light chalky material to a depth of 5 or 6 feet, gradually grading into an Oxnard loam beneath. If no new additions were made by floods the soil would in

time become an Oxnard loam. As it is now it is light and friable and easily cultivated. It has almost the same texture as the Fresno fine sandy loam.

Some of the Salinas shale loam contains a high percentage of gravel and bowlders of the shale from which the soil is formed. Because of their peculiar lightness these bowlders may be transported a long ways by the flood waters. The material of this gravelly soil is the same as the shale loam, except that it is in a less advanced state of decomposition. The Salinas shale loam is sometimes planted to lima beans, which yield from 800 to 1,500 pounds per acre. The soil is a little too far back from the coast for lima beans to yield full crops, and Lady Washington and black-eyed beans are the varieties principally grown. English walnuts seem to do fairly well upon it without irrigation. In seasons of normal rainfall barley yields large crops. Because of its location this soil may be said to be best adapted to the growing of Lady Washington and black-eyed beans or barley. It is always well drained and free from alkali salts.

The following table, containing the results of mechanical analyses of samples of this soil, shows its peculiar texture:

Mechanical analyses of Salinas shale loam.

[Fine earth.]

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Course sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
6173	Las Posas grant.	Shale loam, 0 to 60 inches.	0.59	4.26	0.54	1.24	0.90	5.90	15.80	49.34	21.43
6174	2 miles NW. of Somis.	Shale loam, 0 to 72 inches.	.40	4.22	.62	1.92	1.44	7.18	15.92	44.76	23.44

FULLERTON SANDY ADOBE.

The Fullerton sandy adobe of the part of Ventura County mapped is found northeast of Somis on Las Posas grant and in small areas in the Ojai Valley. It occurs in undulating hills, no considerable areas being level enough to permit of irrigation, even if water were obtainable. This soil is derived from the degradation of a kind of sandstone, and is either formed in place or transported only a short distance. It is a very heavy, sticky, plastic brown sandy adobe 4 to 6 feet in depth, underlain by a compact sandy loam, sand, or decaying sandstone. It is the sandy adobe soil found so extensively near Fullerton, Orange County, and in other parts of California. It is usually planted to

grain, of which it yields good crops. Because of the difficulty of cultivation only small areas are planted to beans or beets. It produces about the same kind of crops as the San Joaquin black adobe. It is always well drained and free from alkali salts.

The following table gives the texture of samples of this soil type:

Mechanical analyses of Fullerton sandy adobe.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
6166	Las Posas grant ..	Sandy adobe, 0 to 30 inches.	0.02	4.24	0.32	0.64	0.76	18.46	6.32	45.86	23.04
6167	Subsoil of 6166....	Sandy adobe, 30 to 66 inches.	.06	3.46	.56	.96	.92	10.16	19.18	45.74	19.28

SAN GABRIEL GRAVELLY LOAM.

This soil is found in but one locality—the eastern end of Las Posas grant and the western end of the Simi Valley. It occurs in rolling hills, no considerable areas being level enough for irrigation. It is a black sandy loam, from 5 to 6 feet in depth, containing a high percentage of rounded granite gravel and underlain by a sandy gravel. It is almost exclusively sown to grain, of which in seasons of normal rainfall it yields good crops. A small area is planted to the black-eyed bean, which yields fairly well. This soil will probably some day be planted much more extensively. It is adapted to grain and the heat-resisting beans. It is always well drained and free from alkali salts.

The following table shows the texture of this soil type:

Mechanical analysis of San Gabriel gravelly loam.

[Fine earth.]

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
6171	1 mile NW. of Epworth.	Gravelly loam, 0 to 18 inches.	0.04	2.82	6.68	13.48	10.06	27.22	6.44	22.48	10.90

DUNESAND.

The sand dunes form a fringe along the ocean side of the valley lands. They are undulating hills of sand formed by the sea breezes, which catch up the sands of the beach and gradually work them inland. In some places the fringe of sand dunes is nearly a mile in width, but at the narrowest places it is but a few hundred feet wide. The dunes are gradually encroaching on the valuable cultivable land adjoining them, this being especially true at their highest and widest point on the Patterson ranch. They are valueless as agricultural lands, except for the very scant pasturage they afford. These sand dunes have cut off all drainage from the valley to the ocean, except at Estero Grande and the mouth of the Santa Clara River, which channels are kept open by the movement of the tides.

The following table shows the texture of Dunesand:

Mechanical analysis of Dunesand.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4660	3 miles W. of Oxnard.	Sand	0.01	0.60	Tr.	24.72	46.34	25.19	0.83	1.68	1.65

METHODS OF CULTIVATION AND IRRIGATION.

The methods of cultivation and irrigation practiced in Ventura County vary so widely that the question is best discussed in connection with the different crops grown.

There are four principal products grown in the area, the most important of which is the lima bean. Ever since its introduction in 1875 changes have been made in the manner of cultivation and general treatment of this crop, until the system seems to be now well-nigh perfect. If the beans are to be planted on land that has been in this crop, cultivation begins as soon as the crop is removed from the field in the fall. Every ten days or two weeks from that time until the last of the winter rains the cultivator is used, the plowing being done just before planting. If, however, beans are to follow barley or sugar beets, the plowing is done in the fall and cultivation kept up during the winter, as described above. Plowing is as deep as can well be done with common plows—10 or 12 inches. Gang plows drawn by 6 or 8 horses are used. The clods are mashed and the soil finely pulverized

with heavy rollers, disk harrows, and an instrument made of a board 2 by 10 or 12 inches, with long twisted knives attached in such a way that when it is drawn across the field it cuts the soil, leaving it in a very good mechanical condition. This process is called "chiseling."

In some cases the land is not plowed at all from year to year, but is kept continually cultivated and is "chiseled" before planting. The beans are planted in May. A machine designed especially for the purpose is used. Four rows are planted at a time, and from 35 to 40 pounds of seed are required to plant an acre. The common practice is to postpone planting until after the last of the rains for two reasons; first, it is much easier to thoroughly stir the ground to prevent the escape of moisture before the crop is planted, and, second, because when the beans sprout and begin to grow the bean itself is pushed up through the soil, and if rain has packed the surface of the soil the plants are unable to penetrate it, and the field has to be replanted.

After the crop is above ground it is cultivated from one to three times to prevent the growth of weeds. For this a 2-horse riding cultivator is used. The shovels of this cultivator differ from those in use for other crops in the fact that they are designed only to stir the soil. The knives are V shaped, one on each side of the row, and pass about 2½ inches beneath the surface, stirring the soil slightly and cutting off the weeds, but not exposing any of the moist earth to the sun.

The beans send out long vines which form a compact mat on the surface of the ground. No poles or stakes are used. They continue to send out new runners and to bloom and produce beans until about the middle of September, or four months from the date of planting, when the harvesting begins. Formerly this was done by pulling up the bushes one by one by hand and placing them in piles to dry. Now a machine has been devised which cuts two rows at a time as fast as a horse can walk. This machine is a sled-like affair consisting of two runners 2 by 16 inches by 6 feet long fastened together, with a width sufficient to span two rows of beans. At the front end of each, on the underside, a heavy knife 4 feet long is fastened, extending backward at an angle of 80 degrees and with the sharp edge inside. As this cutter is drawn through the field each blade cuts a row of beans just beneath the surface of the ground. Long, slender iron rods fastened just above the knives and extending at the same angle push the beans into a windrow in the middle. Men follow with pitchforks and place the beans in small cocks, where they are left to dry three weeks before thrashing.

The greater part of the thrashing is now done with the thrashing machine that is used for grain, with modifications to avoid the breaking and splitting of the beans. Some planters, however, still follow the old method of thrashing by tramping out with horses, horses hitched to disk harrows, wagons, etc. When thrashed the beans

are hauled to one of the many warehouses of the valley, there to await shipment.

In a number of places the beans are irrigated, principally in the vicinity of Santa Paula, on the Dixie Thompson ranch near Ventura, on the Santa Clara del Norte Rancho, and on the Patterson ranch. If 15 inches of rain occur in the winter time very little or no irrigation is necessary to produce good crops. But unless the precipitation reaches this amount, irrigation must be used to produce the best crops. This supplemental irrigation is practiced on all the four principal bean soils, and with very beneficial results, the yield being increased from 500 to 1,000 pounds in dry years. On the Oxnard sandy loam, Oxnard silt loam, and Fresno fine sandy loam the land is by some irrigated only in the winter time. The soil is thoroughly saturated and then cultivated to prevent the escape of moisture. Irrigation is much more cheaply done at this time of year than it is later in the season, after the beans are planted. These soils possess in a remarkable degree the ability to hold moisture. The beans planted after irrigation, or the last rain of the season, grow and mature with no further addition of moisture.

Those planters who do not practice this winter irrigation wait until the latter part of June or the first of July, by which time the beans are good sized bushes, when furrows are made in the alternate spaces between the rows and the water run down these furrows, two rows being irrigated from one furrow. This method is quite expensive, entailing a great deal of extra labor in furrowing and cultivation, but it is particularly beneficial on the very sandy soils, which are of such a loose, open character that water leaches readily through them, causing the winter supply to be more quickly lost.

During the growing season it is the practice of the buyers to send agents around to examine the soils of the bean fields to determine whether there is enough moisture present to mature the crop. The determination depends solely on the judgment of the person examining the soil, for, as far as known, the exact amount of moisture necessary to enable the crop to mature seeds has never been determined. Investigations to ascertain this fact for the various soil types were undertaken by the laboratory of the Bureau of Soils, but unfortunately the work was not commenced until the beans were in blossom. The figures, to be of the most practical value, should be determined every month from the time the crop is planted until the pods are well set and a crop is insured. Yet the ability to evaluate the crop even after it is in bloom is of great service; therefore the data accumulated are given. On the Oxnard silt loam where beans were suffering for water 10.1 per cent of moisture was found, while 100 feet away beans were doing well with 10.7 per cent. Therefore if at the time of blooming this soil contains 11 per cent of moisture a crop of beans is reasonably assured. On the Fresno fine sandy loam beans were suffering with

4.7 per cent of water present and growing nicely with 7.6 per cent, while at another place beans were flourishing with 6.4 per cent. So it seems that at least 6.5 per cent of moisture should be present in this soil at the time of blossoming of the beans. On the Oxnard sand beans suffered with 3.3 per cent of moisture and were growing well with 4.1 per cent. Therefore the necessary amount of water for this soil can be taken as about 4 per cent. All of these determinations were made by drying the soil in the air, determining the loss in weight, and calculating the per cent of moisture on the dry weight of the soil. These figures refer to the upper 3 feet of the soil, for it is thought that the bean plant can make use of moisture throughout that depth. These soils are the principal bean soils of the valley.

Back farther from the coast in the hill lands of Las Posas and Simi Grants and in other places in that vicinity Lady Washington and black-eyed beans are grown. The Lady Washington is a small variety of white navy bean, the black-eyed beans are a little larger and, as their name indicates, have a black spot or eye on one side of each bean. Except when these varieties are grown on the steepest hill slopes the methods of cultivation are about the same as for lima beans. They ripen and are harvested about a month earlier. No areas of these beans are irrigated, since they are planted principally on rolling lands. They mature quicker and are better able to withstand drought and heat than the lima bean.

Next in importance of the cultivated crops of the valley is the sugar beet. The plowing for beets is usually done in the fall after the harvesting season. The ground is plowed 10 or 12 inches deep with 8-horse gang plows, much the same as for beans. This crop has heretofore been nearly all planted in March, but in 1902 the experiment of planting a part of the crop much earlier, soon after the first winter rains, will be made with a view to prolonging the ripening season. The planting is done with a drill in rows 18 inches apart. As soon as the plants get fairly started they are thinned to 9 or 12 inches apart in the row. They are cultivated to conserve moisture and destroy the weeds. About six or seven months after planting the beets mature and are plowed out with an implement that very much resembles an ordinary plow, minus the mold-board. The upright piece is long, so the share passes through the ground 14 to 16 inches beneath the surface. This beet plow is of heavy draft, usually requiring four good horses to draw it. Tops are cut from the beets by hand with a large knife. One man can top and throw into piles from 3 to 8 tons per day, depending upon the size of the beets and thickness of stand. With large scoop forks the beets are thrown into wagons made to hold 4 to 5 tons and hauled to the factory. In some parts of the valley, notably in the Patterson ranch and immediate vicinity, the beets are irrigated. Some irrigate the land before planting and not

afterwards; others irrigate after the beets have come up by making furrows between the rows down which the water is run; still others irrigate both before and after planting. The amount of irrigation necessary is dependent upon the rainfall. In seasons of 15 inches or more of rainfall very little irrigation is considered necessary, but when the precipitation is less than this irrigation must be practiced to obtain maximum crops.

On the upper northern part of the delta of the Santa Clara, between Santa Paula and Saticoy; along the narrow valley of the Ventura River; in the Ojai Valley; about Fillmore, and in other small areas throughout the district mapped, English walnuts and citrus and deciduous fruits are grown. The methods of cultivation and irrigation are practically the same here as in other parts of southern California[a] except that here the deciduous fruits, in most cases, are not irrigated. The past four years, however, having been exceptionally dry, perceptibly damaged these orchards, and many of the trees have died. In the Ojai Valley, despite these dry years, deciduous orchards upon Placentia sandy loam, where water is many feet below the surface, were found in a thriving condition, producing a good crop of fruit in 1901 without any irrigation whatever, although the combined rainfall of the last three years has been less than 30 inches.

The greater part of the walnut orchards and all the citrus orchards are irrigated. This irrigation is principally done by the furrow method; only a few irrigate by basins or by flooding.

Barley is a crop so extensively grown throughout southern California that very little need be said about it here. Barley is not irrigated, and the same methods of cultivation obtain here as are practiced in other parts of the State.

Perhaps no other county in the southern semiarid portion of the State is more abundantly supplied with water than is Ventura County. The Ventura and Santa Clara rivers, with their various tributaries, drain an immense area of mountainous country. The greater part of the rainfall runs off immediately. During the winter season the rivers and their tributaries are rushing torrents. Enough water is retained in the mountains, however, to furnish a small summer supply for irrigation in Santa Clara and Ventura rivers and in Santa Paula and Sespe creeks. This water, with what little is developed at the northern side of Ojai Valley and the artesian belt, beginning at Saticoy and extending nearly due south to the ocean, constitutes the summer water supply of the district mapped. The winter supply, however, is practically unlimited. The rivers and their tributaries, even in the years of lightest rainfall, are, for a part of the winter at least, raging torrents. Every little canyon, though in the summer dry and parched, immediately after a rain

[a] See soil survey around Santa Ana, Cal. Field Operations of the Division of Soils, 1900.

APRICOT ORCHARD NEAR SAT'COY.

DRYING APRICOTS.

begins to run bank full. All this water runs away to the ocean and is lost. It is the general opinion of the farmers that with 15 inches of winter rain large crops can be grown. The annual run-off is enough to increase the supply of water for every foot of irrigable land in the county to much more than 15 inches. All that would be necessary to produce maximum crops every year would be canal systems so constructed as to divert the flood waters upon the valley lands. Surely this is the greatest opportunity for advancement now before the agriculturists in Ventura County. Not only would such a system increase the annual product very materially, but crops would be assured every year, reducing the risk in farming to a minimum. It is not an uncommon thing now in seasons of normal rainfall for $100 worth of beans or beets to be raised upon an acre of land, with the cost of production but $25 to $30 per acre. The maximum price for the land upon which these crops are grown is $300 per acre, very little as yet having been sold for that. If these crops could be assured every year, and a four-year rotation included barley, or some other of the less profitable crops, that but paid the expenses of production, the profit for four years would be $225 per acre, or $56.25 per acre per year. This profit would warrant the expenditure of much more money than is necessary for the development of an extensive system for winter irrigation.

The country north of the Santa Clara River would be especially benefited by such an irrigation system. It is the opinion of the oldest inhabitants that enough water annually runs to waste from Santa Paula Canyon to flood the entire area north of the Santa Clara River that is not already covered by irrigation systems. This soil is all of a high capillary power and retains moisture in a wonderful degree. It is naturally well drained, so that no fear need be entertained of the rise or harmful accumulation of alkali salts.

If the much-needed drainage system should be inaugurated on the south side of the river, a complete irrigation system would be of the greatest benefit in quickly ridding the land of excessive amounts of alkali. The flood waters of Santa Clara River could be made to cover nearly all the lands not possessing artesian water, while the flood waters from the streams of Conejo and Simi valleys would supply the remainder.

Above are enumerated only those benefits of the application of the winter flood waters that result from the additional moisture gained for plant growth. There are other most important benefits to be gained by such an application. The flood waters always carry in suspension a great amount of sediment that is very largely organic matter rich in plant food. Prof. R. H. Forbes, director of the Arizona experiment station, has carried on a long series of investigations, from which he finds that the plant food contained in the water annually applied to the

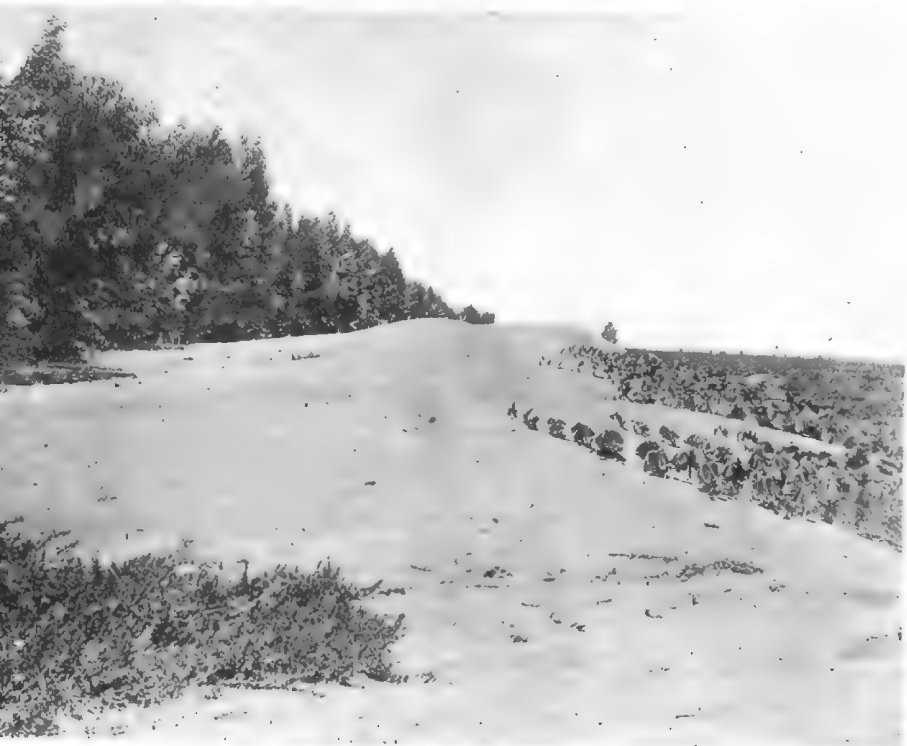
lands in some parts of Arizona is far in excess of what is taken off by the crops, so that the lands, instead of being depleted, are actually made richer each year. Lands on the lower Gila River were examined by one of our soil-survey parties on which 12 inches of sediment had been deposited during twelve years, wholly from the use of flood waters for irrigation. For the sandy, wind-blown soils of parts of the delta of the Santa Clara River this addition of finer particles would be invaluable; the texture of the soil would be improved, its ability to retain moisture and plant food would be increased, and perhaps the area of actual cultivable land would be extended by permitting the removal of the wind-breaks, which prevent the growth of crops for a distance of 40 to 60 feet on each side of them. For this area, where sugar beets, which tend to rapidly deplete the soil, are extensively grown the benefits of this annual addition of plant food can not be too greatly emphasized. It is not enough that a few valuable crops be produced. The wise farmer looks into the future, and so controls the potential fertility of his soil that cultivation rather improves than impairs its condition. While the flood water might not contain all the elements needed for the crops, its application would certainly make more remote the day when the farmers of this valley will be compelled to begin the use of artificial fertilizers. Again, if only the flood waters were applied in irrigation there would be less danger of the accumulation of alkali, as these waters do not become impregnated with these harmful salts by leaching through the soil.

The irrigation systems now in the area mapped are small and few in number. The extension of these would cover larger areas of land, but to cover all of the irrigable land new canals of large capacity should be built.

ALKALI IN SOILS.

All of the lower valley lands of Ventura County contain alkali, but in most cases not in sufficient quantity to injure crops. There is, however, a considerable area where this is not the case, enough alkali being found not only to injure crops, but in some places to make it impossible to grow them. These alkaline lands are nearly all found on the south side of the Santa Clara River. Only three small patches of a few acres each are found on the north side of the river. By referring to the alkali map which accompanies this report it will be seen that the alkaline lands of the valley form a continuous belt, beginning about 2½ miles southeast of Saticoy, on the Santa Clara del Norte rancho, and extending south to the ocean; thence along the coast just inside the sand dunes almost to the point where the river empties into the ocean.

THE DRIFTING OF SAND—NECESSARY THROUGHOUT THE DELTA PORTION OF THE VALLEY.



RIFTING OF SAND ON THE WINDWARD SIDE OF WIND-BREAKS.

ethod of holding the soil, as the trees occupy so much valuable land—crops can not be grown within
ne localities it has been found possible to flood the sands with silt-laden water, which, deposited upon
uctive drifting.

The map shows five grades or percentages of alkali in the soil, the extent of the several grades being as follows:

Areas of different grades of alkali land.

Grade of alkali soil.	Acres.	Per cent.
Less than 0.2 per cent	129,619	84.3
0.2 to 0.4 per cent	8,742	5.7
0.4 to 0.6 per cent	3,808	2.4
0.6 to 1 per cent	2,931	1.9
1 to 3 per cent	4,122	2.7
Over 3 per cent	4,582	3.0

All of the soil types of the delta portion of the valley contain alkali, though not always in harmful quantity. In the lower soils, and in the darker-colored phases of the Oxnard types, the percentage of alkali is much greater than in the lighter-colored and better-drained lands.

The plain on which the alkali occurs was formed by the sediments of the Santa Clara River, which in time of flood spreads outside its bed, flooding the adjacent land.

Three analyses follow, two showing the salts which are in solution in Sespe Creek and Santa Clara River during low water and one giving like data for water of the Santa Clara River when in flood.

Analyses of river waters.

Constituent.	Santa Clara River, 2 miles east of Santa Paula.	Sespe Creek, October.	Santa Clara River, Hueneme crossing, winter.
	Parts per 100,000.	*Parts per 100,000.*	*Parts per 100,000.*
Ions:			
Calcium (Ca)	13.7	7.8	.....
Magnesium (Mg)	6.0	3.6	.....
Sodium (Na)	10.7	12.2	.....
Potassium (K)	.....	0.7	.....
Sulphuric acid (SO_4)	51.1	29.7	.....
Chlorine (Cl)	5.6	11.2	.....
Bicarbonic acid (HCO_3)	25.4	18.4	.....
Conventional combinations:			
Calcium carbonate ($CaCO_3$)	.....	.....	3.2
Calcium sulphate ($CaSO_4$)	46.5	26.5	9.05
Magnesium sulphate ($MgSO_4$)	23.0	13.8	7.5
Sodium sulphate (Na_2SO_4)	.....	.....	6.45
Magnesium bicarbonate ($Mg(HCO_3)_2$)	7.8	4.8	.....
Sodium bicarbonate ($NaHCO_3$)	26.0	19.8	.....
Sodium chloride (NaCl)	9.2	17.4	1.6
Potassium chloride (KCl)	.....	1.3	.....
Silica (SiO_2), iron and aluminum compounds	.....	.....	.....
Total solids	112.5	83.6	53.8

[a] Probably present as bicarbonate of lime ($Ca(HCO_3)_2$).

Though the analyses do not extend over the season, it is thought they give a fair average of the conditions of the water used for irrigation. There is a general similarity in the proportion of the salts present in each of the analyses, making it evident that the sources of the alkali are the same throughout the year. This salt unquestionably originates in the sedimentary rocks of the mountains and foothills. Wherever examined these sedimentary rocks of the Coast Range in California have shown the presence of soluble salts of this type, predominantly sulphates with very small quantities of chlorides and no carbonates. Springs and wells in Ventura and along the base of the hills to Santa Paula frequently contain waters of high salt content, so high as to render them unfit for domestic use. The analyses of these waters, as given in the reports of the California experiment station, show them to be of the same nature as the samples in the table, but more concentrated.

The river water sinking into the subsoil of the plain gives rise to the surface water as found in shallow wells. Analyses of two samples of these surface waters are given below:

Analyses of well waters.

Constituent.	2 miles northeast of Colleguas ranch house.	One-half mile southwest of Moor Park.
	Parts per 100,000.	*Parts per 100,000.*
Ions:		
Calcium (Ca)	7.0	28.0
Magnesium (Mg)	6.2	9.6
Sodium (Na)	14.1	38.6
Potassium (K)	.5	1.2
Sulpuric acid (SO_4)	34.8	130.8
Chlorine (Cl)	7.	23.9
Bicarbonic acid (HCO_3)	33.9	30.3
Conventional combinations:		
Calcium sulphate ($CaSO_4$)	23.7	95.1
Magnesium sulphate ($MgSO_4$)	22.7	47.5
Sodium sulphate (Na_2SO_4)	.....	38.2
Magnesium bicarbonate ($Mg(HCO_3)_2$)	9.6	.....
Sodium bicarbonate ($NaHCO_3$)	35.7	41.7
Potassium chloride (KCl)	.9	2.3
Sodium chloride (NaCl)	18.9	37.6
Total solids	103.5	262.4

These analyses show a variation in the total salt content of the waters, but there is very little variation in the relative proportion of the different salts present. Other analyses by Hilgard and the laboratories of the American Beet Sugar Company show a much wider variation in total solids in solution. As high as 800 to 1,200 parts per 100,000 have been found, the salts being of the same general character.

Carbonates are very seldom found in the well waters, though bicarbonates are always present. The amount of calcium sulphate is always large enough to neutralize the sodium carbonate which would be formed on evaporation of the water, so that black alkali never will be formed under aerated conditions of soil.

The cause of the accumulation of the alkali along the lower portions of the delta is the approach of the subsurface water so near the surface that an upward capillary movement takes place. All of the salt which is in the water is thus deposited near the surface of the ground.

Analyses of a large number of artesian well waters, made by the chemist of the sugar company, show that the average solids in solution is about 135 parts in 100,000, and that the general nature of the salts is the same as found in the river water. The following analysis made in this laboratory is not typical of the artesian waters, but represents the purest type of artesian water found:

Analysis of water from artesian well on Calleguas ranch.

Ions.	Parts per 100,000.	Conventional combination.	Parts per 100,000.
Calcium (Ca)	6.00	Calcium sulphate ($CaSO_4$)	18.09
Magnesium (Mg)	4.00	Calcium bicarbonate ($Ca(HCO_3)_2$)	2.80
Sodium (Na)	8.49	Magnesium bicarbonate ($Mg(HCO_3)_2$).	24.10
Potassium (K)	.79		
Sulphuric acid (SO_4)	12.80	Sodium bicarbonate ($NaHCO_3$)	16.11
Chlorine (Cl)	7.00	Potassium chloride (KCl)	1.50
Bicarbontes (HCO_3)	33.90	Sodium chloride (NaCl)	10.40
Total solids	73.00	Total solids	73.00

The water of the wells of the American Beet Sugar Company, near the factory at Oxnard, shows a higher salt content than that of the artesian well analyzed in the preceding table, and it is more nearly typical of the artesian waters of the plain.

The following analysis by the company's chemist shows the character of the water:

Analysis of water of artesian well at sugar factory, Oxnard.

Constituent.	Parts per 100,000.
Silica (SiO_2)	2.40
Al and Fe oxides	.25
Sodium chloride (NaCl)	17.53
Magnesium sulphate ($MgSO_4$)	25.66
Calcium carbonate ($CaCO_3$)	[a]7.73
Calcium sulphate ($CaSO_4$)	54.44
Sodium sulphate (Na_2SO_4)	33.97
Total solids	136.00

[a] Probably present as bicarbonates.

This analysis is probably typical of a large number of wells in the delta. The use of such water in irrigation is not at all dangerous, provided proper precaution is taken to prevent the accumulation of the salts near the surface of the ground. Only 77 of the 136 parts are readily soluble salts and likely to accumulate to the detriment of plants upon the concentration of the water by evaporation. The other 59 parts are mainly lime salts, which instead of being harmful in any way are of great benefit to growing plants, enabling them to grow in the presence of much larger quantities of alkali salts than where they are not present.

A number of chemical analyses of the alkali soils and crust collected from the area surveyed are given in the accompanying table. These analyses are arranged in order of the content of chlorine. The per cent of chlorine varies from 3 per cent to nearly 50 per cent of the readily soluble salts. Over the greater part of the area the percentage of chlorine is less than 15, and it is only where the lands have recently been flooded with ocean water that the percentage exceeds this amount.

Chemical analyses of alkali soils and crusts.

Constituent.	East side of Saticoy.	4795. Lot 48 E. of ranch house.	One-eighth mile W. of Woods and Leguma roads.	4792. 100 yards S. of experiment station house.	4662. 2 miles SW. of ranch house.	Near mouth of Santa Clara River, S. side.	4798. 50 yards E. of pond No. 2.	One-quarter W. of Hueneme slough.	Standardization solution.
Ions:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Calcium (Ca)	0.59	1.46	1.66	1.31	2.42	4.34	1.29	1.78	0.39
Magnesium (Mg)	5.88	6.47	3.51	5.32	5.68	2.41	7.61	1.34	4.76
Sodium (Na)	22.22	20.55	19.88	22.96	18.26	25.46	20.84	32.92	25.28
Potassium (K)	.82	1.42	1.42	.99	5.48	.99	1.10	1.54	.58
Sulphuric acid (SO_4)	62.05	59.39	61.60	57.38	54.62	50.35	43.02	12.98	56.08
Chlorine (Cl)	7.38	10.16	10.53	11.19	13.30	14.98	25.43	49.19	11.91
Carbonic acid (CO_3)	.03	.....	.18	.....	.27	.....	.71	.....	.....
Bicarbonic acid (HCO_3)	1.03	.64	1.25	.85	.....	1.47	.....	.25	1.00
Conventional combinations:									
Calcium sulphate ($CaSO_4$)	2.81	4.94	5.66	4.42	8.21	14.77	4.40	6.04	1.37
Magnesium sulphate ($MgSO_4$)	29.24	32.08	17.40	26.32	28.13	11.94	37.72	6.67	23.64
Sodium sulphate (Na_2SO_4)	53.53	44.78	56.99	49.21	29.09	46.14	14.52	5.11	53.75
Potassium sulphate (K_2SO_4)	.....	.....	.....	.....	12.20	.....	.....	.....	.....
Sodium chloride (NaCl)	10.81	14.65	15.25	17.00	21.91	23.24	40.34	78.90	18.77
Potassium chloride (KCl)	1.51	2.70	2.72	1.88	.....	1.89	2.08	2.94	1.10
Sodium carbonate (Na_2CO_3)	.69	.....	.26	.....	.47	.....	.94	.....	.....
Sodium bicarbonate ($NaHCO_3$)	1.41	.85	1.72	1.17	.....	2.02	.....	.34	1.37
Per cent soluble	43.45	28.13	38.52	28.28	19.93	16.43	25.48	41.71	6.70

Chemical analyses of alkali soils and crusts.

Constituent.	4793. 250 yards S. of experiment station slough.	4796. Post 44.	One-fourth mile W. of Patterson ranch house.	Lot 56, O. la Colonia ranch.	4794. Dunes W. of Post 49.	4791. Pond W. of Post 25.	4665. One-half mile E. of ranch house.	4 miles E., 1 mile N. Hueneme.	2 miles E. of Huenemc.
Ions:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Calcium (Ca)	1.39	1.20	1.01	0.91	0.89	0.86	1.54	1.34	3.07
Magnesium (Mg)	6.38	5.59	5.92	3.87	6.66	7.78	7.63	2.37	2.11
Sodium (Na)	20.33	21.59	25.84	25.11	20.42	19.13	13.13	27.38	25.46
Potassium (K)	.77	1.17	.58	.82	1.11	.50	8.26	.57	1.14
Sulphuric acid (SO_4)	67.41	65.30	62.51	64.16	65.49	66.74	63.92	61.89	60.49
Chlorine (Cl)	2.72	3.72	3.78	4.32	4.63	4.65	5.28	6.02	6.34
Carbonate (CO_3)	.....	.....	.....	.08	.....	.....	.21	.....	.12
Bicarbonate (HCO_3)	1.00	1.43	.36	.73	.80	.35	.....	.43	1.27
Conventional combinations:									
Calcium sulphate ($CaSO_4$)	4.71	4.07	3.43	3.10	3.00	2.92	5.23	4.57	10.42
Magnesium sulphate ($MgSO_4$)	31.59	27.69	29.36	19.55	33.02	38.55	37.81	11.75	10.43
Sodium sulphate (Na_2SO_4)	57.51	59.64	60.24	68.84	54.79	50.19	29.45	72.92	67.38
Potassium sulphate (K_2SO_4)	.....	.....	.....	.....	.....	.....	18.40	.....	.....
Sodium chloride (NaCl)	3.33	4.39	5.36	5.79	5.98	6.92	8.71	9.06	7.66
Potassium chloride (KCl)	1.47	2.24	1.11	1.57	2.12	.96	.....	1.10	2.17
Sodium carbonate (Na_2CO_3)	.....	.....	.....	.14	.....	.....	.37	.....	.19
Sodium bicarbonate ($NaHCO_3$)	1.39	1.97	.50	1.01	1.09	.46	.....	.60	1.75
Per cent soluble	36.05	37.56	49.25	63.85	57.64	70.96	15.06	28.67	23.28

Several samples contain a large percentage of potash, but on an average less than 1 per cent of the soluble matter is potash.

The alkali does not conform to any of the types given by Cameron[a] in his classification. Since alkali of this general character is found in many places in California along the Coast Range, it is deemed important to establish a new type of alkali—the Oxnard type. In this type the reacting salts are calcium and magnesium sulphates and sodium sulphate, with small quantities of sodium chloride.

The alkali map accompanying this report shows the mean percentage of alkali in the soil, based on the percentage in each foot to a depth of 6 feet.

Five grades of alkali are shown. The first grade comprises lands containing from 0 to 0.20 per cent of alkali. On this grade all cultivated plants do well, and no effect of the alkali can be seen in the yields.

[a] Bulletin No. 17, Division of Soils, U. S. Department of Agriculture, p. 22.

On lands of the second grade—0.20 to 0.40 per cent of alkali—nearly all well-matured plants grow without injury. Many plants are difficult to grow from seed on such soil, since the young plant or seedling is more sensitive to alkali than the well-established or mature plant. Alfalfa occasionally does not catch well on such soils, but if the land is heavily flooded before planting, and is in good tilth, a good stand can generally be obtained. Beans do not do well on this grade, for they are more sensitive to alkali than alfalfa. Beets and barley are not affected by this amount of alkali.

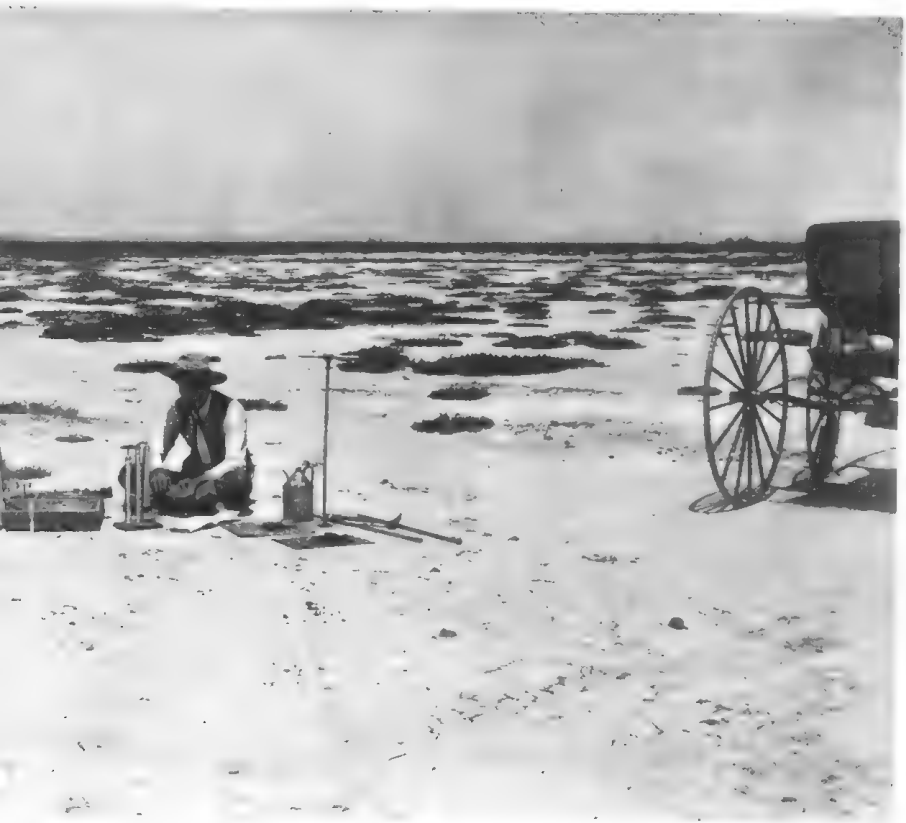
Neither beans nor alfalfa can be seeded successfully on the third grade of alkali lands, which contain from 0.40 to 0.60 per cent of alkali. Alfalfa well established will continue to grow, but it is not as prolific as on better land. Beets and barley can be grown on this grade of land with apparent success.

Lands which contain from 0.60 to 1 per cent of alkali form the fourth grade in the classification. Such lands will not grow any of the cultivated crops, except beets, sorghum, and barley. Even these plants are seen to suffer, and near the upper limit of the grade their culture is uncertain. Salt grass and plants native to the alkali plains thrive and afford pasturage.

On the fifth grade of land—that containing 1 to 3 per cent of alkali—no cultivated plants will grow. Alkali weeds and salt grass alone are able to subsist, but do not afford much pasturage.

The analyses given in preceding pages show a decided similarity in the salts of the crusts and the salts of the river and the artesian belt fed from the river. This justifies a presumption that the alkali has been brought into the valley in the waters of the river. The only other possible source would be the ocean, but there is nothing in the analyses of any of these samples that in any way indicates such an origin. The alkali, when present in harmful quantities, has been concentrated by long-continued evaporation of moisture at the surface of the soil. This moisture is furnished by capillarity when ever the subsoil water rises above a certain depth—a depth measured by the power of attraction latent in the several soil types. Under most of these soils the subsoil water is sufficiently close to the surface to make such connection possible during the greater part of the year. Whenever there is an accumulation of alkali of any kind in sufficient quantity to damage crops there is found associated with it this high water table, and usually the alkali is in a soil of great capillary power.

The water table of the south side of Santa Clara Valley fluctuates very much with the seasons. In the winter time, during the rainy season, it rises very generally, and then gradually subsides as the dry season advances. Over the entire area affected by alkali the water table for the greater part of the year is less than 10 feet, while in the most concentrated places it stands less than 6 feet, from the surface.



KALI FLAT IN THE DELTA PORTION OF THE VENTURA AREA.

nent that there are few areas, even so strongly alkaline as this, that can not be reclaimed at a moderate
ooding, the main requirements being an outlet for the salt-laden drainage waters and irrigation water
o the underdrains.

As a rule the alkali is buried. Instead of the maximum amount being contained in the surface foot, as is very often the case in alkaline districts, the maximum is not reached until the fifth foot. The surface foot in many cases is fairly good, the second a little worse, and so on until the fifth foot is reached, the sixth again being a little better. This location of the alkali in a measure accounts for the fact that in this valley barley was found growing upon lands containing an average for the surface 6 feet of 3 per cent of alkali. There are other reasons for this, however. The alkali here is in the least harmful state; it is all white alkali. There is present in the soil a great deal of calcium in the form of calcium sulphate, and it has been demonstrated that plants in the presence of calcium can withstand larger quantities of alkali than in the absence of this salt. Moreover, barley has been raised a great many years on these same alkaline lands, the seed from the previous crop being sown from year to year, so that this barley may have become in a measure resistant. Sugar beets are also an alkali-resistant crop and are grown quite extensively in the alkaline area, though it was found that land produced good barley crops though it contained so much alkali that only medium beet crops could be grown. The different growing seasons of the two, beets being a summer and barley a winter crop; the difference in root systems, beets going deep into the soil and barley being a shallow-rooted surface crop, and the depth at which the greater part of the alkali is found, are some of the reasons for this. Beets will stand a great deal of water, and when once well started are not greatly affected by an accumulation of alkali at the surface; so if when planted in this alkali soil the beets should be heavily irrigated, creating a rapid evaporation from the surface and removing the alkali from the subsoil to the surface, the one crop would certainly be benefited. The beneficial effects of the first year or so of irrigation on these soils is undoubtedly due to this action. But soon nearly all the alkali is concentrated at the surface, the ground water, already too near the surface, has been permanently raised, and the result is a widening of the alkali area, with a permanent surface accumulation making it impossible to grow even the shallow-rooted crops.

RECLAMATION OF ALKALI LANDS.

If an accumulation of salts of any kind occurs in the soil it must be that at some time there has been a long-continued evaporation of salt-impregnated water at that point. If the salts are so near the surface as to damage crops the concentration has very likely been recent and is still in progress. It may be generally stated for this area that wherever growing crops are being damaged the water table is so near the surface that there is connection between the surface supply and ground water, and that in most cases this ground water is the direct source and the cause of accumulation of the alkali. Any method of

reclamation that does not remove this cause can but be temporary. The methods of cultivation, irrigation, or application of gypsum that have been recommended may be a relief for a time, but they can be of lasting benefit only as they are aids to the final reclamation, which must be done through the removal by drainage of the excessive ground water.

The application of gypsum, if of benefit at all, is so only when the greater part of the accumulated salts is sodium carbonate, commonly known as black alkali. All the alkali of Ventura County is what is known as white alkali. There is present in this district no sodium carbonate, but, on the other hand, large excess of gypsum, so that the only possible way of improving the alkaline lands must be by a mechanical removal of the salts, and the only known way of thoroughly doing this is by draining the land, and letting the salts be carried away, as they were brought in, by the water.

The first question that every man of business, be he farmer or merchant, must ask in regard to any change of method, or proposed investment, must necessarily be, Will it pay? Will it pay to drain the alkaline lands of Ventura County? That these salts can be gotten rid of with an unlimited amount of money no one doubts. But all the questions of feasibility eventually narrow down to the one great question of dollars and cents.

There are now in the alkaline area about 9,000 acres of practically worthless land, which if cleansed of alkali could be made to produce the finest of crops. That this reclamation can be accomplished is no longer a mere theory, for nature herself has given one of the finest demonstrations of the benefits to be derived from drainage of alkali lands. Beginning near the schoolhouse on Wood road, about a mile southwest of Springville, and running on down through the Broom ranch, is a deep gully, the remnant of a branch of the Santa Clara River bed when the river flowed south to Estero Grande. This gully is everywhere several feet deep, and for the last 2 miles of its course it runs through some of the worst alkali lands in the valley. On each side of this natural drainage ditch, for a little over an eighth of a mile, the land is almost free from alkali. On this long, narrow strip of land excellent crops are grown, making an oasis in the broad alkali flat. Another of these natural drains, with similar phenomena, occurs a little more than a mile west of this one. These natural drains could be very cheaply deepened and made to serve as main outlets for a large drainage system, with lateral tile drains leading to the various affected parts of the area. Nearly all the soils of the alkali area are porous, admitting the free passage of water, so that with ample irrigation water, which may be obtained from artesian wells or the water flow of the river, and a drainage system, the reclamation would be very rapid.

The distance to which the lands are reclaimed on each side of the natural drains above mentioned is a valuable key to the distance apart it will be necessary to place drains in similar soils of the same area. The soil, the physiography, and water supply of the valley all favor this reclamation by drainage.

On the Patterson ranch, where much greater difficulties were encountered, where the expensive main ditch had to be excavated and a large pumping plant installed and maintained to raise the water over the sand dunes. The drainage in the eastern part of the alkaline area could be done for much less, for no pumping plant is necessary and the main ditches are supplied by nature. There is, of course, a part of the land so near the sea level as to be affected by tide water, which could never be profitably reclaimed. But by far the greater part of the alkali lands of the valley could be reclaimed at a cost not to exceed $25 per acre. The proceeds from one good crop would more than repay this expense, and the lands after drainage would be worth several times their present value. Every facility is at hand for the farmers of the valley to enhance the value of their lands, for with the installation of this drainage system and the irrigation system spoken of elsewhere the value of real estate over the entire valley must advance greatly.

The lands which are only slightly affected by an excess of alkali are yet capable of producing paying crops of sugar beets, but their value is impaired to a certain degree. It is not possible to grow all the crops adapted to the valley on them. For example, lima beans are very sensitive to alkali and are always a failure on lands which contain an excess of salt. Therefore such lands are not as valuable as the well-drained lands, for their cultivation must be restricted to the one crop, sugar beets, which in time, without rotation, will exhaust the soil.

The cultivation of lands partly damaged by alkali salts is moreover always attended with risk, for any change in the distribution of the salts is likely to cause a greater accumulation of the salts at the surface, and a consequent depreciation in value of the land. It has been shown that underneath many areas which are at present unaffected by alkail at the surface, the subsoil is charged with enough alkali to damage or ruin the land if the level of standing water is ever allowed to rise so close to the surface as to permit rapid upward capillary movement of the water. Irrigation of these lands is necessary to produce maximum crops. It is likely that the level of subsurface water will be raised by irrigation, and conditions brought about favorable for the accumulation of alkali at the surface. Therefore, as a precaution against such probable occurrence, the installation of some permanent system of drainage is most strongly recommended. It is thought that

drains one-eighth to one-fourth mile apart will keep the level of standing water far enough down to prevent damage.

On the Patterson ranch these drains to prevent the rise of the subsurface water have been placed at intervals of from one-eighth to one-half mile, depending upon the character and condition of the soil.

HISTORY AND PRESENT CONDITIONS OF AGRICULTURE.

Agriculture in what is now Ventura County had its beginning at the establishment of the mission at San Buena Ventura in 1782. For a great many years, however, the cultivated lands were all in the immediate vicinity of the mission. Cattle and sheep were raised extensively on the plains that are now the fertile fields of the valleys. All of the valley lands and much of the hill lands of the county were originally Mexican grants. About half a century ago the cultivation of some of these grants began, although stock raising continued to be the chief industry until about 1869 or 1870, when some of the principal grants were subdivided and sold for farming purposes. The same fights, in court and out, between the squatters and the alleged owners of these grants took place here as in other parts of California, with the result that the title to most of the grants was confirmed in whole or in part.

The first cultivation on La Colonia grant, which constituted the greater part of the cultivable lands of the delta of the Santa Clara, began in the latter part of the sixties. Wheat, barley, and corn were the crops first grown. Wheat, however, soon proved to be unprofitable, as the foggy weather almost invariably caused it to rust. From this time until the introduction of lima beans in the early seventies corn and barley were the principal crops. Lima beans were a success from the beginning of their cultivation, and as a ready sale was always had for them they soon grew in popular favor and became a permanent crop. For many years the county was practically cut off from the rest of the world. But for an occasional steamer that would stop at this point, communication was by wagon road or trail. In 1871 the shipping from the port of Ventura was sufficient to justify the building of a wharf, from which was shipped the greater part of the exports of the county until the building of the Hueneme wharf, a few years later. The existence of these wharves, assuring regular visits of freighting steamers, gave great impetus to agriculture, and the growth from that time until the completion of the Santa Barbara branch of the Southern Pacific Railroad in 1886 was rapid and permanent. The advent of the railroad gave quick and direct communication with the East, making possible the marketing of the perishable products of the valley. From this time beans gradually supplanted the other crops of the valley lands until there was a general alarm of overproduction. Almost the

entire crop sold at one time for $1.45 per hundred, delivered at the warehouses. This low price was caused by an unusually large crop—600,000 sacks—produced when marketing facilities were very poor.

The year 1897 was the most important year in the agricultural development of the county. It was in this year that the American Beet Sugar Company constructed at Oxnard, which was then a bean field, one of the largest sugar factories in the world. Much of the land which before had been planted exclusively to beans was now alternated with sugar beets. The result was a reduction of the crop and a consequent rise in price of beans, so that for the year 1900 the product brought from $4.50 to $5.50 per hundred pounds, while in 1901, at the time of harvesting, beans were selling for $4.20 per hundred pounds. The crop for that year has been estimated at 350,000 sacks of 85 pounds each, which, at $4.20 per hundred, brought to the farmers a revenue of $1,349,500. The beans are all shipped to the Eastern States by rail. A few are exported to England, but only when the price to the buyer can be made less than $3 per 100 pounds. Many of the difficulties of marketing and overproduction could, it is thought, be controlled if the farmers of the county had an association patterned after the fruit or walnut associations of California to regulate the marketing of the product.

The cultivation of the sugar beet in the valley began in earnest in 1897. Experiments had been made which showed this area to be particularly well adapted to the growing of the beet, and this led to the building of the sugar factory at Oxnard. This factory has a daily capacity of 2,000 tons of beets, and during 1901 converted into pure granulated sugar 170,000 tons of beets, which, at $5.50 per ton, about the average price in that year, added $935,000 to the income of the growers. The factory buys the beets on a sliding scale depending on the sugar content. Beets containing 15 per cent of sugar or less bring $5, with an additional 25 cents per ton for each additional point above this. The average sugar content is about 17 per cent. Beets have been brought to the factory that were more than 25 per cent, or one-fourth their weight, actual sugar. The farmers sign contracts for a term of years to grow so many acres of beets.

Some damage has already been done to the land by some of the farmers, who signed contracts for almost their entire farms, thus necessitating continuous beet growing on the same soil. The company now, however, have a competent corps of scientific agriculturists, who have the direction of planting and harvesting, and who endeavor by careful suggestion to install such systems of rotation as will preserve the natural fertility of the soil.

Beets grown in the immediate vicinity of Oxnard are delivered at the factory by wagon. The company also has delivery stations at the

various railroad switches throughout the valley and pays the same price for beets at these that it does at the factory.

English walnuts are quite extensively grown in some parts of the county. Just when they were introduced is not known, but there are trees which are apparently fifteen or twenty years old. There are walnut associations for cooperative marketing at Saticoy and Santa Paula, which are a part of the general organization of walnut growers in southern California. The walnut groves are in good condition and yield a good return on the investment.

Citrus fruits are not grown so extensively as in other parts of southern California, as the heavy fogs are detrimental to them. Several carloads are annually shipped, however, justifying the maintenance of packing houses at Santa Paula and Fillmore, a few also being packed in private packing houses on the ranches.

Chief among the deciduous fruits is the apricot. The last few dry years have greatly lessened the amount of this product and usually the orchards that die are not replanted. The fresh fruit brings from $15 to $20 per ton. This fruit is nearly all dried, being too perishable to ship long distances. Other deciduous fruits grown are prunes, peaches, apples—in fact, all the common varieties of fruit are grown, but in a small way, not on a commercial scale. There are no canneries in the district.

Barley is grown upon lands considered of no value for other cultivated crops, or is merely sown for rotation. It is never irrigated. Its yield, and therefore its price, depends wholly upon the rainfall. In excessively dry years none is raised, and when the rainfall is heavy the crop of the county is enormous. This uncertainty makes the growing of barley a hazardous occupation. Much of the hay and grain raised in the hills is consumed in the valleys, where lands are too valuable to be devoted to such a crop. The remainder is shipped by boat to points along the coast, or is shipped out of the county by railroad.

Corn, which was once such an extensive crop, is now found only in small patches. Pumpkins are grown in a small way as feed for milk cows. Flower and garden seeds are quite extensively grown for eastern seed houses. Potatoes and vegetables are shipped from the county, but only in very small quantities.

Stock raising has been almost crowded out of the valley. The last large stock farm to be turned over to cultivation was the Patterson ranch, which for years was devoted almost exclusively to horse raising. Now the horses for farm work are nearly all bought in adjacent markets. No pasture lands of any extent are found in the valleys, although cattle and sheep yet graze on many of the hills and mountains.

In the area mapped there are the towns and villages of Ventura (the

county seat), Oxnard, Santa Paula, Hueneme, Nordhoff, Saticoy, Montalvo, and Fillmore, besides a number of country post-offices and stores. The coast line of the Southern Pacific Railroad traverses the county, coming in along the coast from the north and branching at Montalvo. One branch reaches Los Angeles by way of the Santa Clara Valley and the San Fernando tunnel, the other going on through Oxnard toward Chatsworth Park, where a tunnel is now in process of construction. This route will greatly shorten the distance to Los Angeles.

Agriculture in the county may, as a whole, be said to be in a very thriving condition. Real estate has never had the fictitious value that it has had in some other parts of southern California, the rise in value having been gradual and justifiable.

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U.S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF

ALKALI MAP

CALIFORNIA
VENTURA SHEET

VENTURA
SATICOY
MONTALVO
EL RIO
SPRINGVILLE
Oxnard
HUENEME
PACIFIC OCEAN
SANTA CLARA RIVER
Barranca
Prince
Arrundel
Barranca
Branch
Harmon
DEL NORTE AVE.
ANGELES AVE.
VINEYARD AVE.
SANTA CLARA AVE.
OLD CONEJO ROAD
GONZALES ROAD
WOODLEY ROAD
VENTURA ROAD
SAVIERS ROAD
RICE ROAD
WOOD ROAD
LAGUNA ROAD
PLEASANT VALLEY ROAD
HUENEME ROAD
26
25

LEGEND

- -0.2 — Less than 0.2 per cent
- 0.2-0.4 — From 0.2 per cent to 0.4 per cent
- 0.4-0.6 — From 0.4 per cent to 0.6 per cent
- 0.6-1 — From 0.6 per cent to 1 per cent
- 1-3 — From 1 per cent to 3 per cent
- +3 — Over 3 per cent

Alkali Surveyed by
J. Garnett Holmes and
Louis Mesmer
1901

BASE MAP REDRAWN
FROM COUNTY MAP

Scale 1 inch = 1 mile

A. Hoen & Co. Lith. Baltimore, Md.

Field Operations
Bureau of Soils
1901.

U.S. DEPT OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF

SOIL MAP

CALIFORNIA
VENTURA SHEET

SOIL PROFILE
(6 feet deep)

River wash — S Gr
Fresno sand gravelly phase — S Gr
Fresno fine sandy loam — Ssc f
Oxnard silt loam — Ssc, Sic
Oxnard sand — S
Oxnard sandy loam — Ssc, Sc
Oxnard loam — Sc, Sc
San Joaquin black adobe — Ad
Placentia sandy loam — Ssc, Sad
Salinas shale loam — Sc Gr, Sc
Fullerton sandy adobe — Sad, Ssc St
San Gabriel gravelly loam — Ssc Gr, S Gr
Dune sand — S

LEGEND

S	Sand
Ssc	Sandy loam
Sc	Loam
Sic	Silt loam
Sad	Sandy adobe
S Gr	Sand and gravel
Sc Gr	Loam and gravel
Ssc Gr	Sandy loam and gravel
Ssc f	Fine sandy loam
Ad	Adobe

LEGEND

Rw River wash
Fs Fresno sand gravelly phase
Fsl Fresno fine sandy loam
Ost Oxnard silt loam
Os Oxnard sand
Osl Oxnard sandy loam
Ol Oxnard loam
Sad San Joaquin black adobe
Psl Placentia sandy loam
Ssl Salinas shale loam
Fsa Fullerton sandy adobe
Gl San Gabriel gravelly loam
Ds Dune sand
Gravel areas

Soils Surveyed by
J. Garrett Holmes and
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1901

BASE MAP REDRAWN
FROM COUNTY MAP

Scale 1 inch = 1 mile

A. Hoen & Co. Lith. Baltimore, Md.

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